Review Article

Hip Fracture Surgery: Perioperative Outcomes across Different Anesthesia Techniques – A Systematic Review

Sangeetha Chikkegowda, B. Aparna, Malathi Anil Kumar, Bharath Kumar K, Vijayakumar M Heggeri[1], K. Pushpalatha[2]

Department of Anaesthesiology, Sanjay Gandhi Institute of Trauma and Orthopaedic, [1]Department of Anaesthesiology, Sri Jayadeva Institute of Cardio Vascular Sciences and Research, Bengaluru, [2]Department of Anatomy, JSS University, JSS Academy of Higher Education and Research, Mysore, Karnataka, India

Abstract

Total hip arthroplasty (THA) and total knee arthroplasty (TKA) can benefit from various regional anesthesia (RA) techniques that enhance patient outcomes. Our study aimed to determine if RA reduces mortality, cardiovascular morbidity, deep venous thrombosis (DVT), pulmonary embolism (PE), blood loss, surgery duration, pain, opioid-related side effects, cognitive defects, and hospital stays while improving rehabilitation. A systematic review of randomized controlled trials (RCTs) from 2000 onward compared RA to general anesthesia (GA) and evaluated systemic versus regional analgesia. The evidence from RCTs did not conclusively show that anesthesia type impacts mortality, cardiovascular issues, or DVT and PE incidence with thromboprophylaxis. However, RA may reduce blood loss. Our findings emphasized the importance of individualized analgesic approaches, such as fascia iliaca compartment block, intrathecal morphine, local infiltration analgesia, pericapsular nerve group block, lumbar plexus block, and erector spinae plane block, to optimize pain management and minimize opioid use, highlighting a need for balanced risk–benefit strategies to improve recovery. Surgery duration showed no significant difference between RA and GA. Regional analgesia was more effective in reducing postoperative pain, morphine use, and nausea and vomiting compared to systemic analgesia. Despite these benefits, hospital stay length and rehabilitation outcomes were not significantly influenced by RA or analgesia methods for THA and TKA.

Keywords: Regional and general anesthesia, systematic review, total hip and knee arthroplasty

Introduction

Many regional anesthesia (RA) procedures can be used to perform total hip arthroplasty (THA). Using peripheral nerve blockade (PNB), one can reduce pain in the operated limb specifically while avoiding some of the unintended side effects of central nerve blockade.[1] Because continuous PNB offers longer postoperative pain treatment than single-injection methods, its use has expanded. RA has several disadvantages despite its low risk of problems and apparent advantages in some orthopedic surgeries, such as better postoperative pain treatment, rehabilitation, and shorter hospital stays.[2] Even for skilled practitioners, block operations have an inherent failure rate. Two criticisms of RA are operating theatre delays and the disadvantage of increased liability. Additional constraints include the cost of ultrasound apparatus, which is expected to rise in prominence as a nerve localization technique, and training to acquire the technical skills necessary for effective RA.[3] Many people have misunderstandings and anxieties regarding RA. Despite the growing utilization of these techniques, large meta-analyses and randomized controlled trials (RCTs) that compare RA and general anesthesia (GA) for major lower limb orthopedic surgery frequently yield contradictory results.[4] It is noteworthy that the findings of meta-analyses often diverge from those of significant RCTs. Drugs utilized in landmark studies contrasting GA and RA for hip surgery are no longer available. Surgical procedures and patient care following surgery have greatly advanced within the last 20 years.[5] Because of improved needle technology, block insertion methods, catheter design, and infusion pumps, RA has advanced, and new thromboembolic prophylaxis regimens have been established. To resolve these concerns,

Address for correspondence: Dr. K. Pushpalatha, Department of Anatomy, JSS University, JSS Academy of Higher Education and Research, Sri Shivarathreeshwara Nagara, Mysore, Karnataka, India.
E-mail: lathamurugesh1674@gmail.com

Submitted: 21-Jun-2024 **Revised:** 03-Aug-2024
Accepted: 06-Aug-2024 **Published:** 16-Dec-2024

Access this article online

Quick Response Code:

Website: http://journals.lww.com/amit

DOI: 10.4103/amit.amit_80_24

How to cite this article: Chikkegowda S, Aparna B, Kumar MA, Kumar KB, Heggeri VM, Pushpalatha K. Hip fracture surgery: Perioperative outcomes across different anesthesia techniques – A systematic review. Acta Med Int 2024;11:179-90.

we have examined current data for applicability and relevance to contemporary anesthesia practice. To determine if RA or regional analgesia was better than GA or systemic analgesia for total hip replacement, we systematically evaluated the literature published after 2007.[6] Our review sought to provide specific answers on the effects of RA or regional analgesia on mortality, cardiovascular morbidity, pulmonary embolism (PE), deep vein thrombosis (DVT), length of stay, pain, and adverse effects associated with opioids.

Materials and Methods

Database search strategy

A thorough search was conducted across databases such as Embase, ScienceDirect, PubMed, Scopus, and Web of Science to identify studies comparing "total hip replacement" OR "THA." "Anaesthesia" or "analgesia" was combined with these search results using the Boolean search operator.

Eligibility criteria

This study analyzed case studies, cross-sectional studies, and prevalence studies from 2014 to 2023, focusing on the comparison of GA with regional anesthesia for surgery. The research included both localized and systemic approaches to postoperative analgesia. Exclusion criteria included joint arthroplasty, merged hip and knee arthroplasty, or failure to provide distinct information about knee surgery patients. Clinical trials using analgesics, not freely available in full text, focused on musculoskeletal disorders, duplicate records, or neuraxial approaches limited to opioids were also excluded. The dataset used for comparison included year of publication, authorship, patient number, mean age, male-to-female ratio, and comorbidities. Specific results were sought in each article, including cardiovascular morbidity, DVT, PE, duration of surgery, pain, adverse effects of opioids, cognitive impairments, length of stay, and rehabilitation. Primary or secondary results were ascertained.

Data synthesis and quality assessment

The study screening process involved reviewing study titles and abstracts, assessing eligibility, and resolving disagreements. Qualitative assessments were conducted on outcomes for each intervention and comparison. Criteria such as authors, publication year, study design, sample size, participant ages, comorbidity, intervention, and length of stay were used. The AXIS tool, introduced in 2016, was used to evaluate study design, reporting quality, and bias risk in cross-sectional studies. All articles were assessed for eligibility and methodological quality using 20 items covering objectives, methodology, results, and outcomes.

Sample size

A total of 175 documents were identified through database searches. After removing duplicates, 100 documents remained. Eighty-nine full-text articles were excluded for various reasons, including wrong study design or comparator, being a letter to the editor, lack of full text, or being non-English. Ultimately, 11 articles were included in the review [Figure 1].

Statistical analysis

A descriptive synthesis of the extracted data from various selected studies is presented. This study considered a weighting procedure for the clinical effectiveness of the included studies of comparing RA with GA and assessing systemic versus regional analgesia only when the procedure for combining data from multiple studies was satisfied. Because of the low or negligible prevalence of mortality in each study, the continuous outcomes measures were computed and expressed as a weighted mean difference with 95% confidence intervals. To summarize the findings across the studies, a statistical significance of *P* was also considered.

Assessment of risk of bias

One investigator initially screened the articles according to the inclusion and exclusion criteria, followed by a second investigator conducting a subsequent review. Discrepancies were resolved through a consensus method, and a third review author was consulted if disagreements persisted. If the authors could not be reached or the information was unavailable, the criterion was marked as "unclear." The Cochrane risk of bias tool from the "Cochrane Handbook for Systematic Reviews of Interventions" was used to evaluate the risk of bias, with each criterion rated as "low risk," "high risk," or "unclear."

Results and Discussion

A comprehensive search across databases like Embase, Science Direct, PubMed, Scopus, and Web of Science identified 175 documents on "total hip replacement" (THA) and related anesthesia or analgesia studies. After removing duplicates,

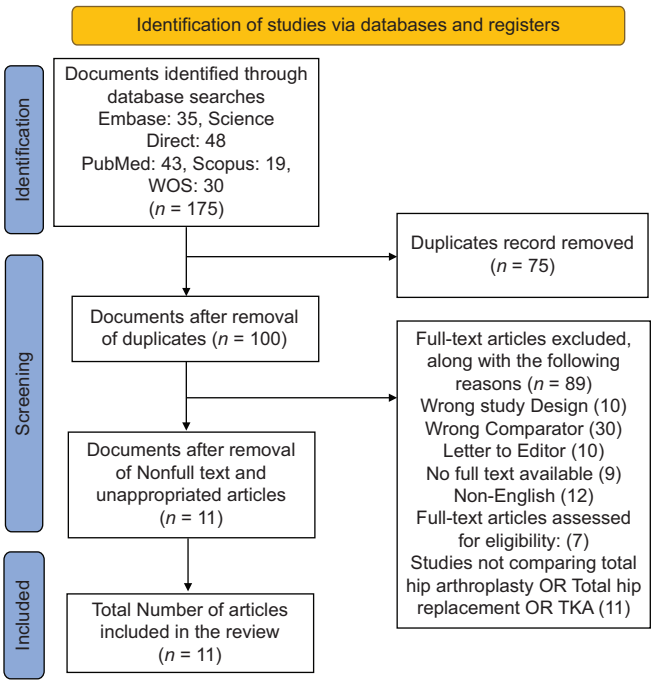

Figure 1: Flowchart

100 documents remained. Out of these, 89 were excluded due to issues like incorrect study design, non-English text, or being editor letters. Ultimately, 11 articles were included in the review. The selection process involved assessing titles, abstracts, and eligibility, and resolving disagreements. The AXIS tool was used to evaluate study quality and bias risk, with a focus on study design, methodology, and outcomes. Total number of subjects varied across studies, with mean patient ages provided. The percentage of male and female patients was recorded, highlighting the gender distribution in each study. Co-morbidity details were also noted, indicating the presence of additional health conditions among participants. The specific datas for each study, including the total number of subjects, mean age, gender distribution, and co-morbidity, were systematically collected and analyzed to assess the impact of these factors on outcomes.

Patients and age

A study involving 109 subjects with a mean patient age of 65 comprised two groups: 28 controls and 29 fascia iliaca compartment block (FICB) patients, all females. Another study examined 80 patients divided into two groups, intrathecal morphine (ITM) and local infiltration analgesia (LIA), with mean ages of 66 (ranging from 51 to 84) and 67 (ranging from 50 to 85), respectively. The female percentage was 41% (16 out of 39), while males accounted for 59% (23 out of 39). In a study of 60 patients undergoing THA, the mean ages were 66.4 (12.4) in the pericapsular nerve group (PENG) group and 66.7 (8.6) in the control group, comprising 57% of males and 43% of females. Another study examined 59 patients with a mean age of 66 years, equally divided by gender, with 50% of males and 50% of females, showing no significant preoperative differences. Research involving 64 patients reported mean ages of 67 years in the saline group and 65 years in the ropivacaine group. The female percentage was 71% in the ropivacaine group and 74% in the saline group. A study included 88 patients aged 18 and 80 years. In the erector spinae plane block (ESPB) group, males constituted 17.5% and females 33.3%, while the control group had 15.9% of males and 33.3% of females. Another study involved 23 patients with a mean age of 63.9 years, divided into 12 participants in the epidural group and 11 in the ESPB group. Research on 64 patients reported mean ages of 71.4 ± 10.1 in the FIB group and 69.3 ± 12 in the ESPB group, including 20 females in the FIB group and 12 in the ESPB group. A study of 73 patients reported mean ages of 69 years (range: 61–77) in Group A and 71 years (range: 60–82) in Group B, comprising 16 males and 19 females. The research included 888 total knee arthroplasty (TKA) patients and 756 THA patients of various ages, with no reported gender distribution. Another study examined 16 patients with a mean age range of 65–69 years without reporting gender details [Table 1].

Intervention (type of anesthesia and analgesia)

The study used supra-inguinal fascia iliaca compartment block (S-FICB) for anesthesia and analgesia, with surgery durations of 106 min for the ITM group and 112 min for the LIA group. A PENG block was used after spinal anesthesia and before incision, with surgery durations of 104 min for the PENG group and 107 min for the control group. The lumbar plexus block combined with morphine analgesia was highly effective for pain management.[18] This technique involves local anesthetic injection near the lumbar plexus, providing comprehensive sensory blockade of the hip. The addition of morphine enhances analgesic efficacy, offering prolonged pain relief. Studies have shown that this combination significantly reduces postoperative pain and opioid requirements while maintaining stable hemodynamics.[19] Spinal anesthesia was used during surgery, with a saline group lasting 62 min and a ropivacaine group lasting 63 min. Lumbar ESPB was administered with ropivacaine, spinal anesthesia, and multimodal analgesia, with case times of 115 min for the ESPB group and 118 min for the control group.[20] Several studies have shown that the use of ropivacaine in conjunction with ESPB results in considerable pain alleviation, a reduction in the use of opioids, and a reduction in the risk of cardiovascular and other systemic problems.[21] Spinal anesthesia is often used in THA to improve postoperative recovery and reduce morbidity. The fascia iliaca block, which blocks nerves that feed the hip, provides extensive pain relief. The ESPB, which blocks the erector spinal muscles, provides extensive pain relief. These procedures are often coupled with spinal anesthesia to improve pain management, decrease opioid use, and potentially reduce the risk of cardiovascular problems. The results show that these techniques are effective in treating hip surgery.[22] The study used RA and opioid-free analgesia for surgery, with surgery durations ranging from 70 min to 6 h. Intraoperative local anesthesia infiltration, wound catheters, and systemic analgesia were also used. RA techniques, including continuous peripheral nerve blockade and catheters, were used, with some procedures having shorter durations. Multimodal approaches were considered superior for pain management [Table 2].

Comorbidity

Cardiovascular morbidity, including hypertension, has been reported in hip replacement surgery. The PENG block for THA showed lower pain scores and reduced opioid consumption, indicating lower morbidity. A comparison of regional anesthetic techniques for unilateral leg surgery showed reduced cardiovascular complications. Deep venous thrombosis (DVT) was noted as a blood clot complication, often seen after hip replacement surgery. Risk factors such as immobility and hypercoagulability were identified, with prevention strategies involving early mobilization and anticoagulation. Vigilant monitoring for DVT postoperatively is crucial, especially after hip surgery. PE is a serious postoperative complication, associated with high morbidity and mortality rates.[23] Preventive measures include anticoagulation therapy, early mobilization, and mechanical prophylaxis like compression devices. Recent advancements emphasize the importance of individualized risk assessment to optimize prophylaxis.[24,25] Postoperative pain management (RA) strategies can significantly reduce the

Table 1: Comparison of total number of subjects, mean patient age, percentage male/female, and comorbidity

Study	Total number of subjects	Mean patient age	Percentage male/female	Co-morbidity
Gola *et al*.[7]	109 subjects	The mean patient age in the study was 65 years	The percentage of females was Controls - 28 FICB - 29	The comorbidities included hypertension, overweight, ischemic heart disease, and diabetes, among others
Kuchálik *et al*.[8]	80 patients	Group ITM - 66 (51–84) Group LIA - 67 (50–85)	The percentage of females was 41% (16 out of 39), and the percentage of males was 59% (23 out of 39)	NR
Pascarella *et al*.[9]	60 patients	PENG - 66.4 (12.4) Control - 66.7 (8.6)	In the study, 57% of the male and 43% of the female participants underwent THA	The study included adults undergoing primary hip arthroplasty with ASA physical status 1–3. Patients with ASA physical status 4 or more, dementia, or cognitive impairment were excluded from the study
Stevens *et al*.[10]	59 patients	The mean patient age in the study was 66 years, with similar preoperative characteristics between the plexus and control groups	The study included 50% of male and 50% of female patients, with no significant gender-based differences in preoperative characteristics	NR
Lennon *et al*.[11]	64 patients	Saline - 67 years Ropivacaine - 65 years	The percentage of females was 71% in the ropivacaine group and 74% in the saline group	NR
Townsend *et al*.[12]	88 patients	The patients included in the study were between 18 and 80 years old	In the ESPB group, the percentage of males was 17.5%, and the percentage of females was 33.3% In the control group, the percentage of males was 15.9%, and the percentage of females was 33.3%	The comorbidities reported were diabetes, osteoporosis, sciatica, and herniated disc
Hanych *et al*.[13]	23 patients	The mean age of the patients in the study was 63.9 years	A total of 23 participants were recruited, with 12 in the epidural group and 11 in the ESPB group	NR
Flaviano *et al*.[14]	64 patients	FIB group: 71.4±10.1 ESPB group: 69.3±12	FIB group (female) - 20 ESPB group (female) - 12	NR
Becchi *et al*.[15]	73 patients	The mean patient age in Group A was 69 years (range: 61–77) and in Group B was 71 years (range: 60–82)	The study documented 16 males and 19 females	NR
Andersen *et al*.[16]	888 (TKA patients) and 756 (THA patients)	NR	NR	NR
Turnbull *et al*.[17]	16 patient	The mean age was 69–65 years	NR	NR

FICB: Fascia iliaca compartment block, ITM: Intrathecal morphine, LIA: Local infiltration analgesia, PENG: Pericapsular nerve group, FIB: Fascia iliaca block, ESPB: Erector spinae plane block, TKA: Total knee arthroplasty, THA: Total hip arthroplasty, NR: Not reported, ASA: American Society of Anesthesiologists

incidence of postoperative pain (PE), a serious condition that can occur postoperatively, especially after hip replacement surgery. These strategies, particularly RA, can help reduce complications such as DVT and PE, which can lead to fatal outcomes. However, the thorough care of cardiovascular problems and deep vein thrombosis (DVT) is particularly noteworthy, making them the best overall strategy in terms of safety and effectiveness. Postoperative immobility and surgical trauma increase the risk of DVT, making RA a crucial component of RA.[26] Prophylactic measures, such as anticoagulant medications and mechanical compression devices, prevent DVT.[27] Early mobilization and physical therapy are also essential components of patient care to reduce the likelihood of clot formation. Vigilant monitoring for symptoms such as swelling, pain, and redness in the legs is crucial for early detection and management of DVT [Table 1].

Mobility and rehabilitation

Studies have shown that patients with asymmetric thigh mobility, a common issue in hip replacement surgery, experience better rehabilitation outcomes. The FICB group showed better outcomes, including range of motion and ambulation, with lower pain scores postoperatively. Patients receiving the PENG block showed better outcomes, including physiotherapy postsurgery. Targeted physical therapy and postoperative exercises are crucial for addressing these mobility differences. Advancements in surgical techniques and rehabilitation protocols also contribute to better management of this condition.[28] The study found that posthip

Table 2: Intervention (type of anesthesia and analgesia), cardiovascular and other morbidity (myocardial infarction, arrhythmia, and hypotension), deep venous thrombosis, pulmonary embolus, duration of surgery, length of stay, and mobility

Study	Intervention (type of anesthesia and analgesia)	Cardiovascular and other morbidity (myocardial infarction, arrhythmia, and hypotension)	DVT	Pulmonary embolus	Duration of surgery	LOS	Mobility
Gola *et al.*[7]	S-FICB	Cardiovascular morbidity included hypertension	DVT in hip replacement	NR	NR	The LOS for the participants in the study was reported as 5–6 days	NR
Kuchálik *et al.*[8]	ITM and LIA	Risk of infection	DVT in prophylaxis	Pulmonary embolus, a serious condition, was among the exclusion criteria in the study on postoperative pain management for elective THA	The duration of surgery for the patients undergoing THA in the study was around 106 minutes for the ITM group and 112 min for the LIA group	The study focused on home readiness as a more accurate endpoint rather than LOS after THA, with no significant differences found between the groups in terms of LOS (2–6 days)	Mobility was assessed postoperatively in patients by measuring the time to home readiness and attempts to mobilize after surgery
Pascarella *et al.*[9]	PENG block after spinal anesthesia and before incision, injecting ropivacaine 0.375% in iliopsoas muscle plane	PENG block for THA showed lower pain scores and reduced opioid consumption, indicating lower morbidity	DVT is a blood clot forming in a deep vein often seen after hip replacement surgery	NR	The duration of surgery for the patients undergoing PENG in the study was around 104 min for the control group and 107 min for the LIA group	The LOS for the participants in the study was reported as 2–3 days	Mobility was assessed regarding range of motion and time first to walk. Patients receiving the PENG block showed a better range of motion and a shorter time to first walk than the control group
Stevens *et al.*[10]	GA and LP block with morphine analgesia were interventions used for THA in the study	Cardiovascular effects of two regional anesthetic techniques	DVT was observed as a potential complication of THA and can be mitigated by appropriate management strategies	NR	The duration of surgery for the patients undergoing plexus in the study was around 130 min for the control group and 132 min for the control group	NR	The study suggests that patient observations, including asymmetric thigh mobility, epidural blockade, and decreased opioid requirements, may introduce bias among patients and data collectors
Lennon *et al.*[11]	The study used spinal anesthesia intraoperatively and local anesthetic infiltration with oral multimodal analgesia postoperatively	One patient in the saline group had transient severe bradycardia postoperatively	NR	NR	The duration of surgery for the patients undergoing saline in the study was around 62 minutes, while for the ropivacaine, it was 63 min	The LOS in the study was longer than expected due to local health policies and patient/surgeon expectations	The study focused on postoperative mobility after hip arthroplasty, with delays attributed to orthostatic intolerance rather than pain
Townsend *et al.*[12]	The intervention involved lumbar ESPB with ropivacaine, spinal anesthesia, and multimodal analgesia	NR	DVT risk factors include surgery, immobility, and hypercoagulable states; prevention involves early mobilization and anticoagulation	NR	Case time (min) ESPB group - 115 min Control group - 118 min	The LOS for the participants in the study was reported as 2 days in the ESPB group and 3 days in the control group	NR

Contd...

Table 2: Contd...

Study	Intervention (type of anesthesia and analgesia)	Cardiovascular and other morbidity (myocardial infarction, arrhythmia, and hypotension)	DVT	Pulmonary embolus	Duration of surgery	LOS	Mobility
Hanych *et al.*[13]	Patients received spinal anesthesia with either lumbar ESPB or epidural analgesia postoperatively	NR	NR	NR	The duration of surgery ranged from 70 min	NR	The study compares pain management techniques and mobility outcomes after hip replacement surgery, finding that lumbar ESPB is comparable to epidural analgesia
Flaviano *et al.*[14]	The intervention included FIB or ESPB followed by spinal anesthesia for THA	NR	DVT, a complication linked to hip surgery, is a risk factor due to immobility, surgery trauma, and altered blood flow, necessitating early detection and prevention measures	Pulmonary embolus, a serious condition, occurred postoperatively, particularly after hip replacement surgery, requiring prompt medical attention	FIB group - 80 min ESPB group - 78 min	NR	Motor-sparing techniques, early mobilization, minimizing quadriceps impairment after surgery
Becchi *et al.*[15]	The intervention involved RA and opioid-free analgesia using saline infusion or externally fixed catheters without infusion	Cardiovascular morbidity was monitored during the study, with specific criteria for bradycardia, hypotension, and treatment with ephedrine	NR	NR	NR	NR	The study emphasizes the importance of effective pain control postsurgery for patient ambulation, recovery, and discharge, utilizing continuous nerve blocks to reduce pain levels and aid rehabilitation
Andersen *et al.*[16]	Interventions include intra-operative local anesthetic infiltration, wound catheters for postoperative local anesthesia, and systemic analgesia	NR	DVT was found as a potential complication after TKA and THA surgeries	NR	The duration of surgery ranged from 1 to 6 h for various procedures	LOS varied from 2 to 7 days in the included trials, with reasons for differences not described	Mobility after hip arthroplasty was not improved by periarticular local anesthesia
Turnbull *et al.*[17]	RA techniques, including continuous PNB and catheters	Reduced cardiovascular complications such as myocardial infarction, arrhythmia, and hypotension	DVT is decreased by RA and associated with decreased mortality in patients undergoing total knee replacement	The study highlights the benefits of RA in reducing complications such as deep vein thrombosis, PE, and transfusion requirements, including the risk of PE	The duration of surgery can vary, but it typically lasts around 2–3 h	LOS post-TKA is typically reduced by utilizing fast-track protocols, resulting in improved outcomes	Multimodal pain management, accelerated rehab, cognitive improvement, decreased complications, and cost savings in TKA enhance recovery

S-FICB: Supra-inguinal fascia iliaca compartment block, ESPB: Erector spinae plane block, RA: Regional anesthesia, DVT: Deep venous thrombosis, LOS: Length of stay, THA: Total hip arthroplasty, ESPB: Erector spinae plane block, NR: Not reported, ITM: Intrathecal morphine, LIA: Local infiltration analgesia, PENG: Pericapsular nerve group, GA: General anesthesia, TKA: Total knee arthroplasty, FIB: Fascia iliaca block, LP: Lumbar plexus, PE: Pulmonary embolism, PNB: Peripheral nerve blockade

Table 3: Pain (pain scores), opioid-related adverse effects (nausea, vomiting, pruritus, sedation, urinary retention, and respiratory depression), opioid consumption, cognitive defects, and rehabilitation (range of motion and ambulation)

Study	Pain (pain scores)	Opioid-related adverse effects (nausea, vomiting, pruritus, sedation, urinary retention, and respiratory depression)	Opioid consumption	Cognitive defects	Rehabilitation (range of motion and ambulation)
Gola *et al*.[7]	Postoperative pain management after hip surgery using FICB to reduce opioid consumption and improved analgesia efficacy	Postoperative nausea and vomiting Bradycardia Hypotension	Opioid consumption was higher in controls, with 61.4 mg	NR	Rehabilitation outcomes, including range of motion and ambulation, were significantly better in the FICB group, with lower pain scores during rehabilitation on days 1 and 2 postoperatively
Kuchálik *et al*.[8]	Pain scores were assessed at various time points, showing that patients in the ITM group had lower pain scores at rest at 8 h postsurgery, while those in the LIA group had lower pain intensity during mobilization at 24–48 h	Pruritus, urinary retention	Opioid consumption was compared between ITM and LIA groups, showing minimal differences in dosage	NR	Rehabilitation, including physiotherapy postsurgery
Pascarella *et al*.[9]	Pain was assessed using a 0–10 NRS Scale, with patients indicating perceived pain levels at various postoperative time points	Opioid-related adverse effects include nausea, vomiting, and dizziness; PENG blocks reduced opioid consumption and risk of adverse events	In the study, patients who received the PENG block had significantly lower opioid consumption compared to the control group	NR	Rehabilitation involved ambulation with a walker after 10 h postoperatively, aiding recovery and functionality for hip arthroplasty patients
Stevens *et al*.[10]	Pain scores were significantly reduced in the plexus group with lower morphine consumption; 0 pain was reported in some patients	Opioid-related adverse effects included nausea, vomiting, pruritus, sedation, urinary retention, and respiratory depression in postoperative patients	NR	Cognitive defects were present postoperatively in two patients, leading to their exclusion from data analysis in the study	Rehabilitation after hip surgery involves improving the range of motion and ambulation to regain function and mobility efficiently
Lennon *et al*.[11]	Pain scores were assessed using a NRS with a 2-point difference considered clinically significant. The study evaluates pain using the NRS scores ranging from 0 to 10. It assesses pain at rest and with movement at different time points postsurgery, such as 6 h and 24 h. The study also considers an appreciable analgesic benefit as a 2-point difference on the NRS pain scale	The study reported negligible opioid-related adverse effects, including nausea, vomiting, pruritus, sedation, urinary retention, and respiratory depression	In the study, opioid use was not the primary outcome measure; Quality of recovery-15 was considered more important	NR	Both groups had similar rates of successful mobilization, with orthostatic intolerance being the main limiting factor in rehabilitation
Townsend *et al*.[12]	Pain scores were assessed using the NRS, and there was no significant difference between the groups at 24 h	Opioid-related adverse effects include respiratory depression, constipation, sedation, nausea, vomiting, and potential addiction risks	Opioid consumption in the study was reported in oral morphine equivalents	Inconsistent sensory loss in L1–L3 dermatomes observed postsurgery	Rehabilitation after hip arthroplasty includes a range of motion and ambulation
Hanych *et al*.[13]	Pain scores were measured using the VAS at different times. The study compares pain management techniques and mobility	NR	Total oxycodone consumption with PCA during the first 24 h	NR	Rehabilitation posthip replacement includes measuring muscle strength, pain, and mobility through

Contd...

Table 3: Contd...

Study	Pain (pain scores)	Opioid-related adverse effects (nausea, vomiting, pruritus, sedation, urinary retention, and respiratory depression)	Opioid consumption	Cognitive defects	Rehabilitation (range of motion and ambulation)
	outcomes after hip replacement surgery, finding that lumbar ESPB is comparable to epidural analgesia				motion and ambulation assessments
Flaviano *et al*.[14]	Pain scores were assessed using NRS, with severe pain defined as NRS>5. The study compares femoral nerve block and ESPB techniques for pain management after THA, finding no significant differences and emphasizing the importance of early pain management	Opioid-related adverse effects included nausea, vomiting	Opioid consumption at different time points was compared between the two blocks	Cognitive defects were not mentioned in the study regarding morphine consumption and postoperative pain assessment	Rehabilitation after THA includes a range of motion exercises and early ambulation for optimal recovery and functional outcomes
Becchi *et al*.[15]	Pain scores in Group A were consistently low, whereas Group B experienced higher pain scores, especially during physiotherapy	In Group A, where opioid-free cPCB was used, less rescue analgesia was needed, and less nausea and vomiting were observed compared to Group B, which received intravenous morphine/ ketorolac infusion	The study reported opioid consumption was minimized using opioid-free analgesia techniques post-THA	Cognitive defects, including hepatic or renal insufficiency and dementia, were excluded from the study criteria	Rehabilitation includes early mobilization, focusing on a range of motion and ambulation for optimal recovery outcomes
Andersen *et al*.[16]	The study compares LIA with other pain relief techniques in hip and knee arthroplasty, showing it reduces pain scores and opioid requirements, potentially improving postoperative pain management	NR	Opioid consumption was decreased at 7 and 12 h postsurgery with intraoperative periarticular injection in THA patients	NR	Rehabilitation after TKA and THA included a range of motion and ambulation assessments in the document
Turnbull *et al*.[17]	The study emphasizes the significance of multimodal analgesia in enhancing postoperative pain control and reducing systemic narcotic consumption, utilizing strategies like PNB and per articular injection	Opioid-related adverse effects include nausea, vomiting, pruritus, sedation, and respiratory depression. Opioid consumption affects cognitive function, rehabilitation, and ambulation	Opioid consumption post-TKA is reduced by pregabalin but not gabapentin, according to a study	The study highlights the potential cognitive benefits of RA techniques, including reduced postoperative cognitive delirium and faster discharge times, compared to GA	Rehabilitation includes a range of motion exercises and ambulation training

NRS: Numeric Rating Scale, VAS: Visual Analog Scale, ESPB: Erector spinae plane block, LIA: Local infiltration analgesia, NR: Not reported, TKA: Total knee arthroplasty, FICB: Fascia iliaca compartment block, ITM: Intrathecal morphine, PENG: Pericapsular nerve group, PCA: Patient-controlled analgesia, THA: Total hip arthroplasty, GA: General anesthesia, RA: Regional anesthesia, cPCB: Continuous psoas compartment block, PNB: Peripheral nerve blockade

replacement rehabilitation focuses on restoring mobility, strength, pain reduction, and overall function. Factors such as asymmetric thigh mobility, epidural blockade, and decreased opioid requirements may have introduced bias. Postoperative rehabilitation involved ambulation with a walker after 10 h, highlighting the importance of improving range of motion and ambulation for efficient recovery. The timed test showed similar rates of successful mobilization in both groups.[29] Early mobilization and personalized rehab plans are crucial for optimal recovery and long-term joint health. Patients typically begin therapy within a day postsurgery, progressing from assisted walking to advanced exercises over weeks. Adherence to rehab protocols is essential for optimal recovery. Lumbar ESPB is comparable to epidural analgesia in terms of mobility outcomes. Motor-sparing techniques, early mobilization, and minimizing quadriceps impairment

after surgery are essential. Rehabilitation after total hip replacement (THA) includes a range of motion exercises and early ambulation. Effective pain control and early mobilization are essential for patient ambulation, recovery, and discharge. Multimodal analgesia, including regional nerve blocks and nonopioid medications, minimizes pain and reduces opioid dependence.[30] Early mobilization protocols, involving physical therapy and ambulation, accelerate functional recovery, reduce postoperative complications, and improve patient satisfaction. Comprehensive perioperative care in hip replacement procedures is crucial. Combining efficient pain management with early mobilization approaches is the most successful strategy for postoperative mobility and rehabilitation. Consistent studies emphasize the importance of nerve blocks in healing, ambulation, and discharge [Table 2 and 3].

Pain management

Postoperative pain management and opioid-related adverse effects were key studies. Techniques such as FICB, ITM, and LIA were used to reduce opioid consumption and improve analgesia efficacy. Pain assessments using the 0–10 Numeric Rating Scale and Visual Analog Scale showed lower pain intensity in the PENG block group. Early pain management was emphasized, and LIA and multimodal analgesia reduced systemic narcotic consumption. Opioid-related adverse effects such as nausea, vomiting, and respiratory depression were consistently reported. Combining these approaches appears to be the most effective method for postoperative pain treatment [Table 3].

Features of the study

The studies in Table 4 focus on various aspects of pain management and outcomes in different surgical procedures. One study examined pain severity and analgesic consumption, while another found lower rescue analgesic consumption and fewer side effects. Recent studies indicate that advanced multimodal pain management strategies in hip replacement surgery lead to lower rescue analgesic consumption and fewer side effects.[31] Techniques, such as RA, perioperative NSAIDs,

Table 4: Outcome of the study, limitations, features of the study, recommendations, and critical influencing factors

Study	The outcome of the study	Limitations	Features of the study	Recommendations	Critical influencing factors
Gola *et al*.[7]	Pain severity, analgesic consumption were studied	Small sample, local factors, short follow-up	Small sample size, very few limitations, effective analgesia	Recommendations for effective analgesia: Use S-FICB Reduce opioid use Shorten hospital stay Ensure high patient satisfaction	Pain management methods
Kuchálik *et al*.[8]	Lower rescue analgesic consumption and fewer side effects	The exact placement of the catheter in the hip joint remains unclear and unexplored	It assessed morphine consumption, pain scores, analgesic use, and side effects. The randomized, double-masked design and specific patient population provided robust findings on postoperative pain management efficacy and safety	LIA is a good alternative to spinal morphine for postoperative pain management in patients undergoing total hip replacement	Patient motivation, time of day for tests, absence of relatives at home, distance to medical facility, day of surgery
Pascarella *et al*.[9]	The study showed lower pain scores and reduced opioid consumption in patients receiving PENG block after hip arthroplasty	Limitations include potential biases, small sample size, and lack of detailed pain assessment methods	The study compared PENG block and control groups, highlighting potential benefits in postoperative pain management and reduced opioid use, assessing pain scores and opioid consumption	Perform PENG block for THA with 20 mL of ropivacaine 0.375%, following Girón-Arango's technique for analgesia	Patient randomization, PENG block technique, opioid consumption, pain scores, block performed before incision, ropivacaine injection, and experienced anesthetists
Stevens *et al*.[10]	The study showed reduced isoflurane use, decreased blood loss, lower pain scores, and less morphine needed in patients with plexus block	Limitations of the study include potential bias due to observations affecting blinding and the need for further research	The study on THA found that using a LP block reduced opioid administration, reduced blood loss, and improved pain management compared to a control group	The study suggests that posterior LP block improves anesthetic and analgesic management in THA but recommends further research to extend the benefits postoperatively and explore reduced bleeding	Preoperative characteristics, isoflurane administration, mean arterial pressure, blood loss, supplemental fentanyl use, and duration of surgery

Contd...

Table 4: Contd...

Study	The outcome of the study	Limitations	Features of the study	Recommendations	Critical influencing factors
Lennon *et al*.[11]	Patients in both groups had similar pain levels and quality of recovery after surgery with spinal anesthesia and ultrasound-guided ESPB	Limitations of the study included the lack of dermatomal assessment for block efficacy and potential differences in opioid use between groups	A blinded, placebo-controlled trial evaluates ESPB for hip arthroplasty, finding limited benefits and small-scale limitations in pain management	Further studies are needed to assess ESPB benefits in opioid-tolerant or complex hip surgery patients for improved outcomes	Orthostatic intolerance and local analgesic infiltration may have influenced outcomes in the study of ESPB for hip arthroplasty
Townsend *et al*.[12]	Opioid consumption, pain scores, and adverse events were assessed	Blinding, inconsistent sensory loss, premature termination	Patient recruitment, randomization, blinding, data curation, and investigation	Larger randomized trials are needed to evaluate lumbar ESPB benefits on opioid requirements after hip arthroplasty and explore longer-acting local anesthetics	Critical influencing factors include patient age, surgical procedure type, anesthesia method, medication allergies, and previous opioid use
Hanych *et al*.[13]	Total oxycodone consumption, PCA demands, pain levels on VAS, muscle strength, timed-up test, satisfaction, and quality of recovery were assessed	The study did not directly compare lumbar erector spinae plane block to epidural analgesia, impacting the generalization of results	The study measured oxycodone consumption, pain levels, muscle strength, mobility, vital signs, and patient satisfaction posthip replacement. Statistical analysis included a *t*-test, Mann–Whitney *U*-test, and various measurements	Provide adequate postoperative pain control with oxycodone PCA, assess muscle strength using the Lovett Scale, and monitor mobility using TUG	Critical influencing factors: pain control, quality of recovery, muscle strength, timed up and test, and heart rate changes
Flaviano *et al*.[14]	No significant difference in morphine consumption, pain scores, or better sensory blocks with FIB compared to ESPB	The study did not assess long-term outcomes beyond 1-year postsurgery for chronic postsurgical pain	Baseline characteristics, sensory block assessments, postoperative outcomes, and chronic pain assessment	Consider using FIB for more reliable sensory blocks, monitor for chronic postsurgical pain, and expand the sample size for generalizability	Sensory testing with FIB, morphine consumption, motor block intensity, and chronic postsurgical pain assessment
Becchi *et al*.[15]	Patients in Group A had significantly lower pain scores at rest and during physiotherapy compared to Group B	Small sample size (37 and 36 patients) Noncompliance with rehabilitation protocol Lack of details on specific outcomes	Randomized trial with successful spinal anesthesia, cPCB analgesia, functional LP catheters, and matched patient characteristics	Recommendations for opioid-free analgesia after THA include spinal anesthesia, cPCB analgesia, and continuous infusion with catheters	Successful analgesia, functional catheters, patient compliance, and matched characteristics influenced pain scores and study outcomes
Andersen *et al*.[16]	Analgesic efficacy of peri-articular injection in TKA and THA, postoperative opioid consumption, and length of hospital stay	The lack of direct comparison and meta-analysis of study outcome measures (pain, opioid requirements)	RCTs with 888 TKA and 756 THA patients assessing analgesic efficacy and opioid consumption	Optimize LIA use based on procedure-specific evidence	Procedure type, multimodal analgesia, opioid-sparing, length of stay, patient outcomes, and future research priorities
Turnbull *et al*.[17]	The study highlights the advantages of fast-track patient recovery after orthopedic procedures, such as reduced LOS, reduced analgesic intake, improved cognitive delirium, faster discharge, and reduced readmissions	The limitation of the study was the need for a more detailed analysis of specific anesthesia techniques during total knee replacement	The study evaluated the analgesic effects of perioperative gabapentin in TKA through RCTs	The study suggests utilizing gabapentin for postoperative pain management in TKA based on various studies	Preoperative patient education, multimodal analgesic regimens, peripheral nerve block, postoperative interventions, and accelerated rehabilitation maximize outcomes

LP: Lumbar plexus, cPCB: Continuous psoas compartment block, S-FICB: Supra-inguinal fascia iliaca compartment block, LIA: Local infiltration analgesia, VAS: Visual Analog Scale, ESPB: Erector spinae plane block, PENG: Pericapsular nerve group, PCA: Patient-controlled analgesia, THA: Total hip arthroplasty, TUG: Timed up and go, FIB: Fascia iliaca block, LOS: Length of stay, TKA: Total knee arthroplasty, RCTs: Randomized controlled trials

acetaminophen, and minimally invasive surgical techniques, enhance recovery.[32] PENG block, a method used to reduce pain and opioid consumption in hip arthroplasty patients, has been shown to improve patient outcomes and satisfaction.[33] PENG block, a technique targeting sensory nerves around the hip, provides pain relief, reduces opioid use postoperatively,

and enhances patient comfort, promoting faster recovery and improved outcomes.[34] Regional anesthesia improves patient outcomes by providing targeted pain relief and minimizing general anesthesia need, leading to faster recovery times and fewer side effects, with studies showing similar pain levels and recovery qualities.[35] Recent investigations highlight the importance of regional anesthesia in optimizing recovery and reducing opioid consumption, pain scores, and adverse events related to hip replacement surgery.[36] Postoperative pain management strategies such as nerve blocks and multimodal analgesia are gaining popularity as alternatives to opioids, enhancing recovery and reducing complications in hip replacement surgery outcomes.[37] Opioid-sparing protocols reduce oxycodone usage while maintaining pain control, achieving similar relief over 90 days. Effective pain management and multimodal analgesia enhance recovery and satisfaction.[38] Several studies have found no significant differences between groups in pain scores and sensory blocks. Research comparing various anesthesia techniques and postoperative pain management protocols has found that outcomes are generally similar regardless of the specific approach used.[39] Both regional anesthesia and GA, as well as different analgesic strategies, provide comparable pain relief and sensory block effectiveness.[40] The study suggests that personalized anesthetic techniques, including multimodal analgesia and patient-specific interventions, can improve postoperative outcomes and patient satisfaction in hip replacement surgery patients, despite compromising pain management outcomes, based on factors such as patient preference or medical history.[41] These findings highlight the importance of customized pain management in enhancing recovery and reducing discomfort in hip replacement patients. The analgesic efficacy and length of hospital stay were evaluated. Effective analgesia is crucial for postoperative recovery and reducing hospital stay in hip replacement surgery.[42] Studies show optimized analgesic protocols, including opioid-sparing techniques, improve pain management, and shorten hospital stays, emphasizing the importance of personalized pain management strategies for hip replacement surgery.[43] Critical influencing factors included patient characteristics, anesthesia methods, and postoperative care protocols. These studies contribute valuable insights into optimizing pain management and patient outcomes in surgical settings.

Conclusion

The study underscores the critical role of tailored analgesic techniques in optimizing postoperative outcomes for patients undergoing THA and TKA. Techniques such as S-FICB, ITM, LIA, PENG block, lumbar plexus block, and ESPB significantly reduce pain scores and opioid consumption. These interventions contribute to improved mobility and rehabilitation outcomes. Despite their effectiveness, each technique carries specific risks and limitations, necessitating careful consideration in clinical practice. Effective pain management strategies enhance patient comfort, reduce hospital stay durations, and improve overall satisfaction. However, the evidence from RCTs did not conclusively show that the type of anesthesia impacts mortality, cardiovascular issues, or the incidence of DVT and PE with thromboprophylaxis. Blood loss may be reduced with RA, but the duration of surgery showed no significant difference between RA and GA. Regional analgesia was better at reducing pain, morphine use, and nausea after surgery compared to systemic analgesia. However, it did not significantly affect hospital stay length or rehabilitation outcomes. Future research should focus on larger sample sizes and longer follow-up periods to validate these findings and refine pain management protocols for orthopedic surgeries.

Author's contribution statement

SC and AB carried out the experiment and collected the data and analyzed the data; MAK conceived and presented the idea; BKK Analysed the data; and PK encouraged and supervised the findings of this work and guided the entire work; VM drafted the manuscript and aided in designing and writing the manuscript.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Hebl JR, Kopp SL, Ali MH, Horlocker TT, Dilger JA, Lennon RL, *et al*. A comprehensive anesthesia protocol that emphasizes peripheral nerve blockade for total knee and total hip arthroplasty. J Bone Joint Surg Am 2005;87 Suppl 2:63-70.
2. Peters CL, Shirley B, Erickson J. The effect of a new multimodal perioperative anesthetic regimen on postoperative pain, side effects, rehabilitation, and length of hospital stay after total joint arthroplasty. J Arthroplasty 2006;21:132-8.
3. Bowness J, Taylor A. Ultrasound-guided regional anaesthesia: Visualising the nerve and needle. Adv Exp Med Biol 2020;1235:19-34.
4. Shin HJ, Woo Nam S, Kim H, Yim S, Han SH, Hwang JW, *et al.* Postoperative delirium after dexmedetomidine versus propofol sedation in healthy older adults undergoing orthopedic lower limb surgery with spinal anesthesia: A randomized controlled trial. Anesthesiology 2023;138:164-71.
5. Hu S, Zhang ZY, Hua YQ, Li J, Cai ZD. A comparison of regional and general anaesthesia for total replacement of the hip or knee: A meta-analysis. J Bone Joint Surg Br 2009;91:935-42.
6. González Della Valle A, Serota A, Go G, Sorriaux G, Sculco TP, Sharrock NE, *et al*. Venous thromboembolism is rare with a multimodal prophylaxis protocol after total hip arthroplasty. Clin Orthop Relat Res 2006;444:146-53.
7. Gola W, Bialka S, Owczarek AJ, Misiolek H. Effectiveness of fascia iliaca compartment block after elective total hip replacement: A prospective, randomized, controlled study. Int J Environ Res Public Health 2021;18:4891.
8. Kuchálik J, Granath B, Ljunggren A, Magnuson A, Lundin A, Gupta A. Postoperative pain relief after total hip arthroplasty: A randomized, double-blind comparison between intrathecal morphine and local infiltration analgesia. Br J Anaesth 2013;111:793-9.
9. Pascarella G, Costa F, Del Buono R, Pulitanò R, Strumia A, Piliego C, *et al*. Impact of the pericapsular nerve group (PENG) block on postoperative analgesia and functional recovery following total hip arthroplasty: A randomised, observer-masked, controlled trial. Anaesthesia 2021;76:1492-8.

10. Stevens RD, Van Gessel E, Flory N, Fournier R, Gamulin Z. Lumbar plexus block reduces pain and blood loss associated with total hip arthroplasty. Anesthesiology 2000;93:115-21.
11. Lennon MJ, Isaac S, Currigan D, O'Leary S, Khan RJ, Fick DP. Erector spinae plane block combined with local infiltration analgesia for total hip arthroplasty: A randomized, placebo controlled, clinical trial. J Clin Anesth 2021;69:110153.
12. Townsend D, Siddique N, Kimura A, Chein Y, Kamara E, Pope J, *et al*. Lumbar erector spinae plane block for total hip arthroplasty comparing 24-hour opioid requirements: A randomized controlled study. Anesthesiol Res Pract 2022;2022:1-8.
13. Hanych A, Kutnik P, Pasiak P, Zakrzewska-Szalak A, Wichowska O, Jednakiewicz M, *et al*. Continuous lumbar erector spinae plane block as an alternative to epidural analgesia in pain treatment in patients undergoing hip replacement surgery – A prospective pilot study. Anaesthesiol Intensive Ther 2023;55:272-6.
14. Flaviano E, Bettinelli S, Assandri M, Muhammad H, Benigni A, Cappelleri G, *et al*. Erector spinae plane versus fascia iliaca block after total hip arthroplasty: A randomized clinical trial comparing analgesic effectiveness and motor block. Korean J Anesthesiol 2023;76:326-35.
15. Becchi C, Al Malyan M, Coppini R, Campolo M, Magherini M, Boncinelli S. Opioid-free analgesia by continuous psoas compartment block after total hip arthroplasty. A randomized study. Eur J Anaesthesiol 2008;25:418-23.
16. Andersen LØ, Kehlet H. Analgesic efficacy of local infiltration analgesia in hip and knee arthroplasty: A systematic review. Br J Anaesth 2014;113:360-74.
17. Turnbull ZA, Sastow D, Giambrone GP, Tedore T. Anesthesia for the patient undergoing total knee replacement: Current status and future prospects. Local Reg Anesth 2017;10:1-7.
18. Fredrickson MJ, Danesh-Clough TK. Spinal anaesthesia with adjunctive intrathecal morphine versus continuous lumbar plexus blockade: A randomised comparison for analgesia after hip replacement. Anaesth Intensive Care 2015;43:449-53.
19. Mostafa RH. Combined sciatic-lumbar plexus block with general anesthesia: Efficacy in preventing tourniquet-induced hemodynamic changes. Open J Anesthesiol 2018;8:100-11.
20. Yi-Han W, Rong T, Jun L, Min W, Yan Z, Yi L, *et al*. Dexmedetomidine combined with ropivacaine for erector spinae plane block after posterior lumbar spine surgery: A randomized controlled trial. BMC Musculoskelet Disord 2022;23:235.
21. Roy N, Parra MF, Brown ML, Sleeper LA, Kossowsky J, Baumer AM, et al. Erector spinae plane blocks for opioid-sparing multimodal pain management after pediatric cardiac surgery. J Thorac Cardiovasc Surg 2024: S0022-5223(24)00211-3.
22. Chen L, Liu S, Cao Y, Yan L, Shen Y. Effect of perioperative ultrasound guided fascia iliaca compartment block in elderly adults with hip fractures undergoing arthroplasty in spinal anesthesia-a randomized controlled trial. BMC Geriatr 2023;23:66.
23. Belmont PJ Jr., Goodman GP, Hamilton W, Waterman BR, Bader JO, Schoenfeld AJ. Morbidity and mortality in the thirty-day period following total hip arthroplasty: Risk factors and incidence. J Arthroplasty 2014;29:2025-30.
24. Glassberg MB, Lachiewicz PF. Changing patterns of anticoagulation after total hip arthroplasty in the United States: Frequency of deep vein thrombosis, pulmonary embolism, and complications with rivaroxaban and Warfarin. J Arthroplasty 2019;34:1793-801.
25. Khatod M, Inacio MC, Bini SA, Paxton EW. Prophylaxis against pulmonary embolism in patients undergoing total hip arthroplasty. J Bone Joint Surg Am 2011;93:1767-72.
26. Kapoor CS, Mehta AK, Patel K, Golwala PP. Prevalence of deep vein thrombosis in patients with lower limb trauma. J Clin Orthop Trauma 2016;7:220-4.
27. Feng W, Wang X, Huang D, Lu A. Ranking the efficacy of anticoagulants for the prevention of venous thromboembolism after total hip or knee arthroplasty: A systematic review and a network meta-analysis. Pharmacol Res 2021;166:105438.
28. Abbas C, Daher J. Pilot study: Post-operative rehabilitation pathway changes and implementation of functional closed kinetic chain exercise in total hip and total knee replacement patient. J Bodyw Mov Ther 2017;21:823-9.
29. Sicard-Rosenbaum L, Light KE, Behrman AL. Gait, lower extremity strength, and self-assessed mobility after hip arthroplasty. J Gerontol A Biol Sci Med Sci 2002;57:M47-51.
30. Marty P, Chassery C, Rontes O, Vuillaume C, Basset B, Merouani M, *et al.* Obturator nerve block does not provide analgesic benefits in total hip arthroplasty under multimodal analgesic regimen: A randomized controlled trial. Reg Anesth Pain Med 2021;46:657-62.
31. Shiyuan Qi, Xiaotong Chen, Ziwei Xu et al. The analgesic effect of Preemptive multimodal analgesia in Direct Anterior Approach total hip arthroplasty: A randomized double-blind trial, 2024. PREPRINT (Version 1) available at Research Square. [https://doi.org/10.21203/rs.3.rs-3987823/v1].
32. Smith HS. Perioperative intravenous acetaminophen and NSAIDs. Pain Med 2011;12:961-81.
33. She C, Liu H. The efficacy of pericapsular nerve group block for reducing pain and opioid consumption after total hip arthroplasty: A systematic review and meta-analysis. J Orthop Surg Res 2024;19:229.
34. Utebey G, Akkaya T, Sayin MM, Alptekin A, Keskin G, Gumus H. Does lumbar plexus blockade provide less blood loss and better analgesia after total hip replacement surgery? Eur J Anaesthesiol 2004;21 Suppl 32:114.
35. Townsend JA, Ganzberg S, Thikkurissy S. The effect of local anesthetic on quality of recovery characteristics following dental rehabilitation under general anesthesia in children. Anesth Prog 2009;56:115-22.
36. Gürkan Y, Yörükoğlu HU, Işık E, Kuş A. The effect of ibuprofen on postoperative opioid consumption following total hip replacement surgery. Turk J Anaesthesiol Reanim 2019;47:31-4.
37. de Beer JD, Winemaker MJ, Donnelly GA, Miceli PC, Reiz JL, Harsanyi Z, *et al*. Efficacy and safety of controlled-release oxycodone and standard therapies for postoperative pain after knee or hip replacement. Can J Surg 2005;48:277.
38. Szewczyk J, Nguyen BH, Villamizar N, Nguyen DM. Achieving pain control with opioid-sparing multimodal analgesic strategy – Doing more with less by enhanced recovery after thoracic surgery protocol: A review. J Anesthesiol Pain Ther 2020;1:1-7.
39. Aksoy M, Dostbil A, Ince I, Ahiskalioglu A, Alici HA, Aydin A, *et al*. Continuous spinal anaesthesia versus ultrasound-guided combined psoas compartment-sciatic nerve block for hip replacement surgery in elderly high-risk patients: A prospective randomised study. BMC Anesthesiol 2014;14:99.
40. Chin A, Heywood L, Iu P, Pelecanos AM, Barrington MJ. The effectiveness of regional anaesthesia before and after the introduction of a dedicated regional anaesthesia service incorporating a block room. Anaesth Intensive Care 2017;45:714-9.
41. Passias BJ, Johnson DB, Schuette HB, Secic M, Heilbronner B, Hyland SJ, *et al*. Preemptive multimodal analgesia and post-operative pain outcomes in total hip and total knee arthroplasty. Arch Orthop Trauma Surg 2023;143:2401-7.
42. Stambough JB, Nunley RM, Curry MC, Steger-May K, Clohisy JC. Rapid recovery protocols for primary total hip arthroplasty can safely reduce length of stay without increasing readmissions. J Arthroplasty 2015;30:521-6.
43. Hannon CP, Fillingham YA, Nam D, Courtney PM, Curtin BM, Vigdorchik JM, *et al*. Opioids in total joint arthroplasty: The clinical practice guidelines of the American Association of hip and Knee Surgeons, American Society of Regional Anesthesia and Pain Medicine, American Academy of Orthopaedic Surgeons, Hip Society, and Knee Society. J Arthroplasty 2020;35:2709-14.